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# THE NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY: DEVELOPMENT AND TRANSFER OF TECHNOLOGY*

by

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## Introduction: Brief History

The National Institute of Science and Technology was established on July 1, 1901 as the Bureau of Government Laboratories (BGL) by Philippine Commission (P.C.) Act No. 156. Although mandated to conduct biological, chemical, and other studies, the main activities of the BGL during this early period were in public health. At that time, diseases such as beri-beri, cholera, diarrhea, dysentery, malaria, and smallpox were prevalent.

On October 26, 1905, the BGL was reorganized and its name changed to Bureau of Science (BS) through P.C. Act No. 1407. The Bureau of Science, through this Act, was mandated to undertake research in all fields of science. In addition, through P.C. Act No. 1519, the Bureau of Science was made the custodian of the international standards of weights and measures in the country.

From 1901 to 1917, the BGL/BS was under the Department of the Interior of the U.S. government - the Philippines being a U.S. colony at that time. But in 1917, it was transferred to the newly created Department of Agriculture and Natural Resources. This indicated a changing role for the Bureau of Science. Greater attention was placed towards making an inventory of the country's natural resources in preparation for its eventual exploitation.

Dr. Paul Casper Freer, head of the Department of Chemistry, University of Michigan was the first superintendent of the BGL in 1901. His title was changed to director when BGL was renamed Bureau of Science in 1905. Three more Americans headed the Bureau of Science: Dr. Alvin Joseph Cox from Leland Standord Junior University (1912-1919); Dr. Elmer Drew Merrill (1919-1924) who later became dean of the College of Agriculture, University of California (Davis) and then director of the New York Botanic Garden; and Dr. William H. Brown (1924-1933). It was only in 1934 when the Bureau of Science had its first Filipino director, Dr. Angel S. Arguelles, a soil chemist.

Soon after the Philippines regained its independence, among the first acts of the Philippine Congress was the passage of Republic Act (R.A.) No. 51, which authorized the President to reorganize the government. The President issued Executive Order No. 94 effective July 1, 1947, converting the Bureau of Science into an Institute of Science and placing it directly under the Office of the President. The Institute of Science was mandated to "make scientific investigations and conduct researches necessary for the promotion and development of industries".

On July 1, 1951, the President issued Executive Order No. 392, renaming the Institute of Science as the Institute of Science and Technology and placed it under the Office of Economic Coordination. By adding the term technology, the President meant to place greater emphasis to the country's industrialization.

On August 23, 1956, Congress passed Republic Act No. 1606 authorizing the establishment of a new scientific body, the National Science Board. The Institute became one of the NSB's agencies and was renamed the National Scientific and Industrial Research Institute.

In 1958, a new Science Act enacted by Congress abolished the NSB and replaced it with the National Science Development Board (NSDB). The NSIRI was renamed, National Institute of Science and Technology (NIST) and placed under the administrative supervision of the NSDB. The head of the NIST was given the title of commissioner and made a member of the governing board of the NSDB. It was mandated to undertake research in all fields of science except nuclear science which was made the responsibility of a sister commission, the Philippine Atomic Energy Commission.

In 1982, Executive Order No. 784, reorganized the NSDB into the National Science and Technology Authority. the NIST became one of the institutes under NSTA and mandated to pursue industrial research and custodian of the international standards of weights and measures in the country.

The NIST today consists of two Centers and three Divisions, namely: the National Research and Development Center (NDRC) which has five research programs: food, microbiological, industrial chemicals, pharmaceuticals, and engineering; the National Standards and Testing Center (NSTC), which has four departments: electronics and acoustics, mechanics and optics, chemistry and biology/toxicology; the Planning and Programming Division (PPD), the Administrative Division, and the Technical Information and Documentation Division (TIDD). Technology transfer activities are directly under the Office of the Director, coordinated by PPD, implemented by NRDC, and documented by TIDD. The Director is appointed by the President of the Philippines and reports directly to the Minister of Science and Technology.

## Early Efforts at Technology Transfer

In the early 1900's, beri-beri was a serious disease afflicting pregnant mothers and newborn babies. Pregnant mothers suffered serious cases of edema while babies died at birth, exhibiting a general darkening of the body. Studies showed that the disease was not pathogenic but caused by vitamin deficiency. The Bureau of Science developed a technology for extracting a thick, ill-tasting syrup from "darak" or rice polishing. The syrup was later termed "tiki-tiki" and a tiki-tiki pilot extraction plant was constructed at the BS compound in 1921. The technology was later obtained by a pharmaceutical company and "Tiki-Tiki, Manuel Zamora", the commercial brand name, became very popular in the 1920s and 1930s. Nursing mothers and their babies took daily doses of the ill-tasting syrup.

The technology for making upper leather was transferred to the Philippine industry from the Bureau of Science. In the 1930s, Mr. Marcos Hermoso, the father of the owner of the largest leather processing firm in the Philippines today, Hermoso Hermanos, Inc., was then manufacturing only sole leather using camachile bark for tanning. The researchers in the Upper Leather Research Laboratory, Organic Chemistry Deparment of the Bureau of Science assisted Mr. Hermoso in acquiring the know-how and technology for producing upper leather. The Bureau of Science had a pilot plant that produced leather of such high quality that the leather used in making the shoes of the then President Manuel L. Quezon was produced from the pilot plant.

## Recent Efforts at Technology Transfer

In 1965, a lady researcher at NIST's Food and Nutrition Research Center started work on the development of a stable and homogeneous

coconut milk (gata) which can be stored in cans or other suitable containers. Preliminary results were discouraging and work was shifted to other projects.

In February 1969, she and two other researchers had a project approved to develop processes for coconut products. Work on the coconut milk technology resumed. On November 25, 1969, the research group had the following entry in their laboratory notebook, "Got fairly stable product with high acceptability". The technology for producing stable, homogeneous canned coconut milk was developed. In April 1970, the researchers were granted Philippine Patent No. 5632 for the "Process of Preparing Coconut Milk and Product Thereof".

Immediately, efforts were exerted to transfer the technology to the private sector and commercialize the product. Laguna Agro-Industrial Coconut Cooperative (LAICC) agreed to cooperate with NIST to establish a pilot plant to produce canned "gata". A contract was signed on April 26, 1971 between NIST and LAICC stipulating that NIST will supply the technology, machinery, and equipment for the pilot plant while LAICC will provide the land, building, access road, and raw materials for the pilot plant. The plant had a capacity of one tonne per day. The NIST staff fabricated the machines and equipment and supervised the installation. By the middle of 1972, the plant was ready for operation.

Unfortunately, numerous technical, financial, organizational, and marketing problems were encountered during the operation of the pilot plant. The product was not readily accepted in the market and the initial cost of production was high. In addition, a number of organizational changes took place at NIST, contributing to further

delays in the project. After seven years of intermittent operation, the NIST decided in 1979 to lease out the plant to Agro-Gold Food Corporation (AFC) which had expressed interest in expanding and commercializing the operation. In 1983, the corporation employed about 40 workers and produced more than six thousand cases. The plant had been expanded and the corporation is now exporting canned coconut milk using the brand name, Coco Manila.

Another recent effort is the transfer of the design and fabrication technology of a coconut expeller from NIST to Filipinas Foundation, Inc., one of the largest private foundations in the Philippines. For a 3% royalty fee based on gross sales, the NIST has assigned to FFI the right to manufacture and sell the mechanical expeller in the Philippines. The Memorandum of Agreement was signed in 1983 and stipulated that the equipment shall be labeled "NIST-FFI Expeller".

Strategy for Technology Transfer

In spite of its long history and its moderate success in scientific research and technological development, the National Institute of Science and Technology has not been quite successful in its efforts to transfer technology to industry. The four cases described earlier are the only recorded cases of successful transfer of technology over its more than 80 years of existence. It may be further noted that since 1947 the Institute of Science was already mandated to "conduct researches necessary for the promotion and development of industry". In fairness to NIST, however, it must be pointed out that the same thing is true for all government-funded research institutes in the Philippines, i.e. the transfer of indigenous technology seems to be where the institutes are weakest.

The biggest stumbling block in the transfer of indigenous technology appears to be in the failure to establish direct linkage between existing industries and the research institutes. In the absence of this linkage, the research institutes tend to concentrate its efforts on new entrepreneurs. Thus the institutes become saddled with multifarious problems of "pushing" the technology, demonstrating the production process, assisting in organizing the firm that will utilize the technology, helping develop the market, assisting in securing loans, and providing feasibility studies. More often than not, the efforts fail since the institute has no expertise in marketing, feasibility studies, financial analysis, and organization. The entrepreneur, on the other hand, often lacks capital and does not have the logistical support to penetrate the market. The new enterprise, short of capital and with no captive market, eventually fails. If the experience is repeated a number of times, the institute losses credibility, thus further widening the gap between the institute and the established industry.

There are other causes for the loss of credibility by research institutes such as: premature attempt to commercialize a technology that is not yet proven; inability of institutes to sustain a technology transfer effort; and the researchers' hesitance in providing all information needed to insure successful technology transfer.

To establish credibility, the research institute must document cases of successful technology transfer and disseminate the information to industry. The institutes must also minimize the risks of failure by making sure: (i) that the technology being transferred is mature and sufficiently proven; (ii) that a market exists for the product; and (iii) that the recipient is sincerely interested in the technology, has the organization, capital and logistics to support the technology

transfer process, and has the marketing network to distribute the product.

To meet these conditions, the institutes must first attempt to transfer its technologies to existing industries. Thus, a direct linkage between the research institutes and industry is a must. The technology transfer effort must be preceded by a thorough evaluation of the technologies to be transferred and a careful selection of the participating industrial firms. Once a reputation for successfully commercializing technologies is established by the institutes, the biggest bottleneck for technology transfer will be eliminated. Succeeding efforts may venture into higher risk situations; but by then the institutes would have gained the experience, expertise, reputation, and credibility associated with previous successes.

Present Efforts at Technology Transfer

In January 1984, the NIST started assessing the technologies it has developed during the recent years to determine which were "mature" enough for transfer to industry. Seventeen technologies were identified and a brochure entitled NIST Mature Technologies was printed to disseminate the information to the public. Further evaluations were made to select technologies for immediate transfer. The selected technologies met two main criteria, namely: (i) the technology is developed to a level that commercialization will not result in too much technical problems; and (ii) industrial cooperators can be found who will need the technology, will financially support the transfer process, and will push the marketing of the product.

In May 1984, five technologies were selected, namely: (i) an improved alcohol fermentation technology using highly active

flocculating yeast fusant; (ii) accelerated fermentation process for the production of premium quality soy sauce; (iii) improved solar salt making technology; (iv) technology for the production of essential oils from local plants; and (v) a new technology for the production of coconut water beverage.

The first technology involves the use of highly flocculating yeast fusant produced by NIST's microbiological research program. The yeast produces 12% (V/V) alcohol in the beer in less than 24 hours with a conversion efficiency of 95%. Since there are 19 alcohol distilleries in the Philippines which produce an average of only 5-6% alcohol in the beer, the technology, if successfully commercialized will have significant impacts on the distilleries' energy consumption, waste generation, and productivity.

With financial assistance from the ASEAN-Australia Protein Program, the NIST has developed an improved process for the production of premium quality soy sauce. With the use of improved strains of yeast, mold, and bacteria, the fermentation time for the full flavor development of soy sauce has been reduced to 3 months from the usual 8-12 months. The product contains more than 8% protein, surpassing FDA requirements, and contains more lactic acid, an important taste component, than local brands.

It is surprising that while the Philippines has 7,100 islands and is surrounded by oceans it does not produce industrial grade salt. A majority of locally produced salt have high moisture content and are of low purity. Thus, locally produced salt is used mainly in fish sauce (patis) and fish paste (bagoong) production. Industrial salt and table salt are imported.

The NIST has developed its salt production technology by operating a pilot salt farm. The pilot plant has consistently produced good quality salt over a number of years. The salt has low moisture content, low in calcium, magnesium and other impurities, and meets the specifications for industiral and food grade salt.

The fourth technology, the production of essential oils from local plants, fruits, and flowers, has been with the NIST for many years and has become an identifying mark of the Institute. Nonetheless, the technology has not been commercialized. The know-how for extracting oils from tanglad, calamansi, ilang-ilang and others has remained within the confines of the science community. In May 1984, it was decided that this know-how must now be transferred to the private sector and commercialized.

The fifth technology involves the production of a stable, nutritious beverage from coconut water. Coconut water is a waste from the production of dessicated coconut and other coconut-based food products. It constitutes a serious pollution problem when discharged into watercourses due to its high biochemical oxygen demand. Its conversion from waste to beverage (jestingly called Coco-Cola) gives it commercial value and renders unnecessary costly wastewater treatment facilities. Since coconut water biodegrades very readily even with refrigeration, the technology for producing a stable, nutritious beverage with a shelf life of 6-8 months is quite an achievement. NIST developed this technology with financial assistance from the ASEAN-Australian Food Waste Program.

In June 1984, evaluation of various firms interested in the five technologies started and negotiations with selected firms were initiated. A strong commitment to support the program and push the

marketing of the product were major considerations in the selection process.

On August 1, 1984, the NIST Integrated Technology Transfer Program was formally launched using funds provided by the National Science and Technology Authority. The objective: to successfully transfer five NIST-developed technologies to industry.

On August 3, 1984, a Memorandum of Agreement was signed between NIST and Victorias Milling Corporation for the transfer of the alcohol fermentation technology. VMC is the largest sugar mill and refinery in the Philippines producing 60% of the country's refined sugar. It was selected for a number of reasons: (i) VMC has a reputation for technical exellence in the sugar industry; (ii) its distillery, which produces 35,000 liters alcohol per day, supplies the anhydrous alcohol requirement of the government's power alcohol (alcogas: 90% gasoline - 10% alcohol) program; (iii) the distillery has a low fermentation efficiency and produces only 4-5% alcohol in the beer; and (iv) VMC made a very strong commitment to support the effort to its successful completion.

NIST engineers and scientists have been working at the VMC distillery since August 1984. The work plan involves: firstly, monitoring and documentation of the performance of the existing facilities to establish baseline data for future comparison; secondly, use of the NIST yeast fusant in the fermentation process, replacing VMC's yeast strain, but without substantial changes in the facilities and operating procedures; thirdly, use of the NIST yeast fusant and introducing whatever equipment and operational changes are needed to obtain optimum results. After two months of effort, initial results indicate that alcohol yields have increased from the present 5% to 10% without change in the facilities. However, the 10% yield has not yet stabilized.

The second Memorandum of Agreement was signed on September 7, 1984 between NIST and Negros Fisheries Corporation (NEFCOR) for the transfer of technology for the production of industrial grade salt. Organized in 1969, NEFCOR is engaged in aquaculture and salt production. It operates a 70-hectare bangus farm, a 4-hectare prawn farm, and an 8-hectare salt farm.

Over a 7-month period, NIST will transfer its know-how to NEFCOR, and the product will be known as the NIST-NEFCOR Industrial Grade Salt. Since NEFCOR has an existing farm, has technicians already knowledgeable in the rudiments of salt making, and has a ready market for its products, the success or failure of the technology transfer efforts depends mainly on the technical aspects of the project.

On October 4, 1984, the NIST signed a Memorandum of Agreement with Universal Foods Corporation, one of the leading food manufacturers in the Philippines, for the transfer of the soy sauce technology. As in previous agreements, the NIST will send a team to UFC to undertake the transfer of technology; make available to UFC the expertise, including the microorganisms in the production of quality soy sauce; and,conduct testing and analyses of products for quality control. UFC, on the other hand, will: make available to the research team all raw materials and resources needed for the production of soy sauce; provide the assistance of UFC technical and non-technical staff in the implementation of the project; and,take care of the advertisement and marketing of the products. It is also stiuplated that the product label shall state "Process developed by NIST".

UFC has the largest share of the banana sauce (catsup) market in the Philippines. It also sells a limited volume of soy sauce which is produced for them on contract. It will formally enter the soy sauce

market equipped with existing modern processing and bottling facilities, an extensive distribution network, and an established name in the food industry. Again, the technology will be the primary factor in the success or failure of the technology transfer effort. The NIST is confident that the project will succeed since premium quality soy sauce has been consistently produced during the past 1-1/2 years in its own pilot plant. Consumer acceptance has also been established through taste tests and test marketing. UFC, itself, has conducted its own testing and evaluation of the pilot production facilities and the product.

On October 8, 1984, the NIST signed a Memorandum of Agreement with Helen's Pharmaceutical Laboratory (HPL), a small pharmaceutical firm in Cagayan de Oro City in Mindanao, for the transfer of NIST's essential oil extraction technology. HPL manufactures various pharmaceutical products, such as liniments, ointments, tinctures, oils, rubbing alcohol, cough syrup, and others. The essential oil produced from local plants and flowers will be utilized in the formulation of the pharmaceutical products in lieu of imported essential oils. Since it is the essential oil component that is the result of NIST technology and not the product itself, the agreement stipulates that the product label shall carry the statement "NIST Technology in Product Formulation".

The technology transfer implementation of the four aforementioned technologies has not met any major problem so far. The careful choice of technologies to be transferred and the meticulous evaluation of the cooperating industrial firms contributed much to the smooth implementation of the program.

The fifth technology selected for transfer, that is, the

coco-beverage production technology, has however, proved to be quite problematic. Although the selection, evaluation, and negotiation process for industrial cooperators started at the same time, an agreement has not yet been signed for the transfer of the coco-beverage technology.

Initially, the coconut dessicators were thought to be the ideal recipients of the technology since they have the raw materials. By converting waste coconut water into beverage, it is converted into a product of commercial value and costly wastewater treatment facilities are avoided. Unfortunately, pollution control laws are not very strictly enforced in the Philippines for economic reasons. Hence, the dessicated coconut firms have the option of simply providing an inexpensive primary treatment facility and discharging partially treated wastewater into the river. To convert waste coconut water into beverage, the firms have to invest sizeable capital on processing, chilling, pasteurizing, and packaging machines. They also have to establish a distribution network. Since coco-beverage is a new product with no proven consumer acceptance and market size, and since fresh coconut water is readily available at least in the coconut growing areas of the country and in Metro Manila, the dessicated coconut firms are reluctant to make the investment. In addition, they claim unfamiliarity with the consumer products market and the distribution system for beverages.

Since the raw material "producers" were not interested, firms already in the beverage business were considered next. Actually, several inquiries expressing interest on the technology were received by NIST from this sector. Some stated the possibility of export markets in Taiwan and Singapore. After evaluating the interested firms in

terms of their manufacturing and marketing capabilities, the choice was narrowed down to Harman Foods Corporation, a medium sized food company which manufactures an orange-flavored drink in laminated containers. Their product, with the brand name, "Zesto", is very popular in Metro Manila. Since the firm has all the facilities for processing, pasteurizing, packaging, and marketing the product, no additional capital investment is needed for producing coco-beverage. The problem is the source of raw material.

Since Harman Foods is located quite far from the main sources of waste coconut water the cost of transporting the coconut water in refrigerated vans became a problem. After months of grappling with the problem another factory was found not too far from Harman that produces waste coconut water - although in much smaller quantities. Negotiations are now underway for the supply of coconut water and the Memorandum of Agreement with Harman Foods will, hopefully, be signed before the end of October 1984. Initially, 100,000 packages of coco-beverage will be produced to determine market acceptability, both locally and abroad. The long term prospect is that there will be a small market in Metro Manila and the major markets will be in Singapore and Taiwan.

These technology transfer cases clearly indicate the need for careful planning to minimize problems and increase the chance of success. It must be realized that research institutes have limited resources and expertise and therefore they should limit their exposure and responsibility.

If ultimately successful, the transfer of the aforementioned five technologies will provide good case histories. A good cross-section of Philippine industry is represented: from a small firm

like Helen's Pharmaceutical Laboratory; to medium-sized firms like NEFCOR and Harman Foods Corporation; to large firms like Universal Foods Corporation; and to very large firms like Victorias Milling Company.

Conclusion: Future Prospects

The National Institute of Science and Technology is fortunate that during the past year it has received strong support from the Minister of Science and Technology. Support has been given to an integrated citric acid research project aimed at developing an indigenous technology for the production of citric acid from clarified sugar cane juice by submerged fermentation process. The project will reach pilot plant stage in 1985 and Canlubang Sugar Estate, one of the major sugar producers in the Philippines, has formally expressed its interest to cooperate in setting up the pilot plant and commercialize the technology.

The NIST has also received financial support to develop the technology for producing bacteriological grade agar (bacto-agar) from local seaweeds. Marine Colloids, Inc., a company producing semi-refined carragennan (SRC) from seaweeds, has formally expressed interest in the commercialization of the technology once fully developed. Pilot studies on bacto-agar production are scheduled in late 1985.

Contract research with the private sector has been and will be intensified since it provides a mechanism for the immediate transfer and commercialization of research results.

The National Irrigation Administration (NIA), a government corporation, is funding a research project for the utilization of

cashew apple. Since NIA is tasked with the management of two multi-purpose dam watersheds, it has initially planted 3,000 hectares to cashew. While there is no problem marketing the cashew nuts, there is a problem regarding the disposal of cashew apple. NIST is presently studying its use for producing cashew juice, vinegar, and animal feeds. Pilot scale operation is scheduled in early 1986.

Avon Products, Inc., a multi-national pharmaceutical company, is funding a research project with NIST for the production from locally available materials and plants, three ingredients for their products. The NIST-produced products will be used in lieu of imported ones. If successful, Avon plans to set up a small commercial plant to supply its needs, using the NIST-developed technologies.

Other on-going contract research projects that lead to immediate transfer of technology to industry are: technology for producing export quality dehydrated spices for BayMark Corporation; improvement of the technology for producing coconut wine (lambanog) to meet export quality requirements for Camaysa Wine Distillery; technology for the utilization of semi-refined carragenan in the treatment of meat processing wastes and using the sludge as animal feed for Marine Colloids, Inc.; improvement of the existing NIST-developed technology for producing instant bean curd (tokwa) so that it can be used as an ingredient in instant soups, and development of technology for producing fruit leather from local fruits, for the Philippine Refining Company.

In accordance with the "demand-pull" policy enunciated by the Minister of Science and Technology, NIST will devote its resources in the development of technologies responsive to industry "demand", and programs to intensify contract research and technology transfer

will be pursued. The technologies being developed now are future prospects for technology transfer. NIST is aiming to establish a tract record of successfully commercialized research results and become a major factor in the country's industrialization effort.

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# COMMERCIALIZATION OF RESEARCH RESULTS*

by

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The topic of discussion is very clear in the sense that it should cover research activities together with commercialization attempts of such results. But it should not be taken literally as clear as it sounds, since both of these concepts are products of a sophisticated society and their synthesis have often been definitely time consuming and loaded with uncertainties not only in the least developed countries like Nepal but also in the advanced countries from where these concepts have emanated. Talking honestly, I feel a sense of loss at the very outset to say that our collective experience in this regard is fragmentary and prone to give rise to misunderstanding and misgivings.

In order to smoothen the international flow of research results and transfer of technology and simultaneously develop local capability, it seems that understanding of technical details do not guarantee the desired outcome, unless some broder issues relating to environment are properly addressed. When most of the developing countries in this region are trying to grapple with the concrete issues they are facing, we, in Nepal, are still searching a viable framework so that it would be effective to solve specific problems arising out of its peculiar geographical position and difficult terrain. I sincerely apologize for any detour from the context, if any,and hope for the sympathetic consideration of this crucial factor by all concerned.

State of Arts of Commercialization of Research Results at National Level

Institutional Arrangements:

Till very recently, there was no central agency responsible for the promotion and development of science and technology as such in Nepal, although there were a member of institutes/agencies engaged in research and experiment of mechanical processes, application thereof and in a very limited way commercialization. Since the history of such effort is of recent origin, it is still uncoordinated and inadequate. Therefore, in order to identify the priority areas, itensify the efforts where needed, eliminate the duplications, coordinate the actions and create and

subsequently nurture the atmosphere conducive to the development of science and technology, the Royal Nepal Academy of Science and Technology (RONAST) was constituted in December 5, 1982 in Nepal.

This event has been emphasized here because of the correctness of approach and tone it has set during this short period of its operation. Although its objectives and policies are broad and all encompassing with regard to development and promotion of science and technology in the country, it is pertinent to note a few areas in which we are presently interested viz. "encouragement to the promotion and application of science and technology in the private sector", and "supervision of application of technology in the industry and other sectors as well as transfer of appropriate technology."[1/] It should be noted that research results need not be purely indigeneous in their content in order to be successfully applied; if their appropriateness with regard to physical environment and human considerations are established. Needless to say that foreign research results are cost effective and yield quick return, if the transfer of technology embodying such research results are adapted to the local needs.

The following table* illustrates the types of adaptive research works undertaken by Nepalese institutes and agencies. Many of them, however, deal with promotion and dissemination of known technologies with little modifications.

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1. Royal Nepal Academy of Science and Technology - Brief Introduction.

* Condensed from a disucssion paper on "Scientific Research, Technology Development, Transfer and Dissemination": Some Guiding Concepts" prepared by RONAST, May 1983.

| Sector | No. of Identified Priority Areas | No.of Research works undertaken (including promotion and dissemination of known technologies) | Institution Involved |
|---|---|---|---|
| 1. Agriculture | 13 | 3 | Dept.of Agriculture, Livestock and Horticulture |
| 2. Irrigation | 8 | 3 | Dept. of Irrigation, UMN, BYS, Nepal Hydro |
| 3. Dottage & Small Scale Industries | 14 | 4 | BYS, SATA, UMN |
| 4. Industry | 20 | 1 | RECAST |
| 5. Transport & Communication | 16 | 4 | Dept. of Road, BYS, UMN |
| 6. Energy | 26 | 14 | BYS, UMN, RECAST, Nepal Hydro RCUP, Institute of Forestry, Dept. of Agriculture |
| 7. Housing & Construction | 20 | 6 | Himal Cement, RECAST, NCCN, HBTF, TMB Shotcrete |
| 8. Education | 15 | 3 | BYS, Dept. of Cottage Industry and Private Institutions |
| 9. Health and Nutrition | 15 | 10 | Royal Drug Ltd., BYS, UMN, Dept. of Agriculture, East Consults. |

The above table reveals the urgency of research works in every area particularly so in the case of industry and cottage and small scale industries although agriculture also lags behind the need together with other sectors in a appreciable way. However tentatively the facts in the

table are assembled and presented, it shows that we have hope in the area of health and nutrition as well as energy sectors. Both the sectors being prime movers for the development of human as well as physical factors, we can be satisfied with ourselves that the direction of effort is not misplaced. Until some breakthrough is attained in these sectors, no progress is possible on other fronts, in spite of mutual interdependence of all the sectors of the economy. But satisfaction would not be worthwhile unless promise is turned into prospect and prospect into practice.

Application of Results and Linking Mechanism

When we talk of linking mechanism, we should distinguish between indigeneous and foreign research results as well as mechanisms because the former is ruled by patent and trade mark laws and regulations while the latter is governed by technology transfer laws and regulations. Sometimes there appears to be no clearcut frontiers between the type of research results and their application mechanisms, but still we maintain this distinction in order to facilitate the analysis.

Indigeneous research efforts, though limited in coverage, have been presently directed towards multipurpose water wheels, small turbines for electricity generation, equipments or devices to use solar energy for the purpose of cooking and water heating and dehydration of vegetables and fruits, adaptation of equipment and mechanism to use bio-gas and bio-mass for producing energy. Alongside, there have been some efforts towards appropriate loom making and appropriate modification in the traditional paper making technology. We will dwell on these in the following pages.

a. Vegetable Dyeing Process:

Here I would like to mention a relatively unpublicized case of vegetable dyeing of woolen carpets for export. Woolen carpets has begun to be exported from Nepal since a decade back as a non-traditional export item. It has seen many ups and downs during this formative period. But from the application of technology point of

view, it suited the ethos and historical consciousness of the Nepalese society. Initiated by a few exporters based on import of raw wool from Tibet, dyes and other stuffs from India and other countries it generated substantial employment of Nepalese labour. With decentralized operation of activities and combined by imaginative local artists and Tibetan refugees craftsmen, this activity gained a momentum of unexpected proportion during later stage. But this scheme had a lacuna in that the imaginative faculty of the local artisens was restricted to the availability of foreign materials due to heavy import content of material components. Therefore, it had to face the fate of decline caused by deterioration in quality, despite the edge of low labour cost. After intense research on the selection of materials coupled with application of new-found dyeing methods developed indigeneously, the export level has been restored after three to four years of uncessant effort. Instead of depending on cut-and-dried dyeing methods and materials, research was carried on along the line to find a suitable combination of locally available materials and processes, by which the aesthetic quality of end products could be enhanced and could be made more appealing to the foreign importers. Still there seems to be enough room for improvement. It has yet to satisfy the equity consideration in that those who are involved at the lowest rung of operation have not benefited proportionally. Thanks that it has attracted the attention of experts and process simplification work is underway. Hopefully the solution will be found out soon.

Elsewhere I have stated that it suited the ingenuity of local populace. Why so ? Firstly, the operations were decentralized and many of which were carried out at home. Secondly, pecuniary risk was undertaken by someone who was well placed to do so. Thirdly, the technology of dyeing has now been based on local resources.

b. Small Water Turbines, and Multiple Use Water Wheel

Nepal abounds with water resources quite disproportionate to her land area.[2] Composed of numerous river valley systems, Nepal's hydro-electric potentiality has been estimated at 83 million KW and per capita avialability at 48,000 KWH. Against this potentiality, the present production capabilities is around 29 KWH per capita. One wonders why such a big gap exists. The answer is quite simple that development of hydro-power requires more in terms of fixed capital formation although operating cost is minimal. Not only that, systematic observation and study over long periods of time is required to assure that the installation might not be washed away. Distribution problems and costs are enourmous again. Therefore, till such time these hurdles are cleared and large scale projects are taken up, appropriate technology in terms of low capacity and low cost turbines have been considered necessary if any improvement in the plight of rural Nepal is to occur. As energy is a pre-requisite to any meaningful economic activities, it was and is still appropriate to advise plans to generate, combine and popularize the cost effective and suitable technology in this regard.

Water has been traditionally a source of power in Nepal. One recent estimate suggests that between 25,000 and 40,000 horizontal water wheels are operating in Nepal.[3] Their operating efficiency was found to be as low as 20% in average. Efforts were undertaken with an aim to replace these inefficient devices by efficient ones. During 1973/74 Balaju Yantra Shala (BYS) Kathmandu developed cross flow turbines and installed a number of them. Since then Butwal Engineering Workshop (BEW) and a few other workshops began manufacturing

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2/ Hydro-electric potential of Nepal's river courses is estimated at 83 million KW. Compared to 0.11% of world area, this potential, turns out to be 1.5% of the world potentiality of hydro-power generation (theoretical). Dr. H.M. Shrestha - "Hydro-electricity Development in Nepal - An Overview" printed in Nepal Industrial Digest 1983.

3/ A Bachman and A.M. Nakarmi - Himalayan Waterwheels (RNAM Newsletter, ESCAP April 1984).

such turbines. Upto now approximately one hundred and fifty of these turbines are functioning all over the country. Of these about seventy are manufactured and installed by BYS, majority of the remainder by BEW and a few by others. In what follows hereafter, the features of BYS equipments and their application is discussed.

BYS equipments have two variants known and T-7 and T-6. T-7 variant is a low capacity (5-20 KW) dismantable and portable machine. Its aim is to replace traditional water wheels and to enable to operate a number of machines simultaneously on account of its higher efficiency levels (more than 2.5-3 times) e.g. rice hulling, wheat and maize grinding, rice flattening, saw milling etc.

Inspite of room for marginal improvement in quality and efficiency, basic consideration in manufacturing this type of cross flow turbine is that its cost be kept minimum in order to suit the financial means of rural people and that it be manufactured in pieces so that it could be carried otherwise even in the absence of modern means of transport and communication.

Another variant i.e. T-6 is amimed to generate electricity. It has relatively higher capacity (upto 50 KW now and possibility of upto 150 KW)than the previous one has. It is a compact model and therefore considerations of reliability and efficiency are taken into account. More than a dozen of outfits are operating now with this type of equipment. A few are exported abroad also. Judging in the context, this piece of equipment is reasonably efficient, its turbine efficiency being within the range of 70 - 75%. Despite being so, only about a dozen machines with 350 KW of cumulative electricity generation capacity have been installed (worth Rs. 2.8 - 3.0 million*) during the course of half a decade's time span.

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* US$ 1 = Rs. 17.40

Bottlenecks: It seems that there is not a single bottleneck but a series of bottlenecks in the process of commercialization of research results. Both internal and external factors (not only to concerned institution) have their proper share of blame. The list would be long and it would inevitably reflect underdevelopment syndrome. Resistance to change due to inability to adjust oneself to a new situation has been one of the critical constraints. "Major negative impact of these water turbines are seen on the traditional water wheels. Large turbines in the locality have killed most of the nearby water wheels. From a large number of these traditional devices only a few is still surviving - some only for the sake of prestige, other just for private purposes and the rest only because they had nothing else to do. Thus investment made for these devices - labour, capital and skills have gone in vain. Many operators who used to work in these water wheels have been compelled to go in search of new jobs."[4/] One of the goals of introduction of improved technology is to release the work force and other resources for other productive purposes. If this transition is not smooth and planned, social problems might prove to be counter productive. It is a concern of the society for whom thewhole process is meant to benefit. Another dimension of the same problem is that "people think that mostly the people of upper level" are benefitted[5/] from such schemes. Therefore, it is not enough to solve a problem from technological point of view only; rather it demands synchronization of activities with specific need of the area. Here it is not necessary to mention other peripheral problems. But the most disgusting part of it is that international organizations who profess formally for the enhancement of local technological capabilities seem to act in a manner detrimental to their professed objective. It is my personal opinion that there is still a long way to go for reduction of undue influence of pressure groups and vested interest (both of the country as well as outside the country).

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4/ Chandra Bahadur Joshi - Sample Survey of Traditional Waterwheels and Small Water Turbines in Nepal, Research Centre for Applied Science and Technology, Tribhuvan University, Kathmandu, Nepal.

5/ Op. Cit.

c. Case of Low Cost Cementious Materials:

Research Centre of Applied Science & Technology, Tribhuvan University, Kirtipur, had conducted research on cementious materials as an alternative to portland cement available in the market during 1977. The rationale was not only to make "low cost alternate cement available for cheap construction, but also at the spot where it is needed."[6/] Moreover, the use of high strength portland cement even for ordinary masonery and plastering work was in fact considered as misuse. Besides high cost, and acute transport problem in remote area, formulation of a cheap cementious materials was considered as appropriate for use in rural Nepal.

In the development of cementious materials, the main raw materials were rice husk (agricultural by products) any lime sludge (wastages of sugar factory). The rice husk cement based on these raw materials had the physical properties as follows:

Comparative Studies of Physical Properties of Rice Husk Cement and Portland Cement[6/]

| Properties | Portland Cement | Rice Husk Cement | Indian Standard as 1966/67 masonary Cement |
|---|---|---|---|
| Fines | | | |
| Specific Surface $cm^2/gm$ | 2500 - 3000 | 5000 | minimum 5000 |
| Soundness | | | |
| Lechatcher Expansion | | 3 mm | maximum 10 mm |
| Autoclave Expansion | | 1 mm | maximum 1 mm |
| Setting Tune | | | |
| Initial Setting | 45 minutes | 45 minutes | minimum 90 minutes |
| Autoclave Setting | 12 hours | 150 minutes | maximum 24 hours |
| Compressive Strength | | | |
| in 7 days ($Kg/cm^2$) | minimum 280 | 90 | minimum 25 |
| in 28 days ($kg/cm^2$) | normally 350-400 33-40% | maximum 200 average 178 50% | minimum 25 |

6/ RECAST Annual Report 1977/78.

On the comparative study of the properties it was concluded that though somewhat inferior in quality to ordinary portland cement, the rick husk cement can be used in masonary, plastering, light foundation even to meet the recent ISI specification for masonary cement. Besides, this cement can be used for the production of cementicus pipes and corrugated roofing sheets.

Since by all means the technology was ripe for commercialization practical problems began to crop up. Now the time did really come for testing the efficiency of the mechanism concerning transfer of technology from laboratory stage to commercial production stage. RECAST applied for the patent of the process, which was duly granted by the Department of Industry HMG/Nepal as per patent Design and Trade Mark Act, 2022 (1966). Then RECAST decided to grant license for manufacturing rice husk cement to any licensees for Rs. 5000 per district.7/ One licensee got the license from RECAST but started manufacturing operation in another district.

In the Act we find that there is one provision which states that nobody should imitate or make known or use by other's name any patent registered under the Act without obtaining written consent from the patent holder during the period mentioned in Article 8. Article 8 states that the patent-holders' right on patent remains valid for 15 years and it is renewable for another 15 years, if the concerned Department is satisfied that improvements have been done by the patent-holder. Moreover, another Article provides that if anybody is found non-compliant or encourages someone to voilate the provisions of this Act, he would be li ble to pay fine of Rs. 500 by the Department's rulling and all the materials pertaining to such violation shall be confiscated. In this case, RECAST being a public institution devoted to th cause of donducting research on technology specially useful for rural areas and promotion thereof, it was a non issue. But supposing a private inventor applies his resources and

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7/ Nepal has 75 administrative districts.

ingenuity and discovers something useful for the public and seeks legal protection to recover the whole or part of his expenses, how the legal framework operates to safeguard his interest? obviously the legal framework is deficient in substantive issues as well as on enforecement aspects. Neither was it aimed that way at the time of commencement. But "the patent system should strike a fair balance between the need for economic and social development and the rights granted by industrial property."[8/] Of course, there is another side of the coin also. There seems to be no basis by which one can judge patentability of the technology or process in question, how long it is actually necessary to grant patent for. Moreover, it is not clear why should any patent which is registered in at least three countries is automatically patentable in Nepal. In sum, the prevalent Patent Design and Trade Mark Act needs thorough review in order to enable it to be an effective instrument of public policy.

d. Other cases

There are a few other case of indigeneous applied research and commercialization.

a) New type of stoves in order to save fuel wood consumption have been successfully designed by RECAST and in now being popularised by encouraging local clay-workers to manufacture and place them in the market. These improved varieties of stoves will save upto 30 - 35% fuel wood.

b) There have been some works at RECAST, BYS and other workshops to design equipments for utilizing solar power in order to dry fruits, vegetables etc. and to warm water for domestic consumption. In addition, efforts are also geared towards manufacturing low cost solar stoves in order to cook meals.

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8/ "Review of recent trends in patents in developing countries", Report by the UNCTAD Secretariate.

c) Some works with regard to bio-gass utilization are underway. Because of diversity of climate, availability of materils, variation in topography etc. not a single version or model is going to be effective throughout the country. These diversities have not only limited the scope of application of these technologies but also posed the problem of availability of construction materials in remote parts of the country where such technologies are badly in need of. Therefore, there is a long way to go until such technologies are made less costly and suited to the requirement of rural people. For example, a model of bio-gas production outfit requires dung from at least four buffaloes and investment of Rs. 7000 - 8000 (i.e. approximately US$ 500).

d) One definite qualitative improvement that was obtained was in the field of cloth weaving through efforts of the Department of Cottage and Small Scale Industries, HMG/N. There was some initial spur towards commercialization of this loom, which was to be operated by footand by hands. It was successful to generate efficiency of upto 3 times as compared to traditional handloom. Commercialization of the technology could not proceed further not because of the unsuitability of the technology as such but because of the lack of organisational factors such as lack of materials, markets etc. and organisation of production units.

e) There has also been effort to develop a low cost fruit preservation unit, which can be used in cold fruit growing areas having no ready accessibility of market. For example, with this device about 50 MT of apples and equally same quantity of potato thereafter can be stored in a specially constructed godown in which temperature would be controlled by opening or closing the number of holes of natural air circulation system and cooling of air can be done by sprinkling water through gravity near the holes. This appently introduced device has been judged as successful. Its application, although bound to be limited in selective areas could be beneficial to the high-land agrarian economy.

## Bottlenecks in the Process of Commercialization of Research Results

As highlighted above, one can get a clear hint that neither adequate research results nor the process of general commercialization in a wide scale is existent in Nepal. However, there have been some efforts, oriented towards finding solution of the rural problems (fittingly so far a country where nine-tenth of the population resides in the villages); such efforts only are far meagre for the purpose. One need not repeat how widespread the canvass of rural poverty hangs over there in the background and how rare the oases of rural affluent people are. In communities where majority of people consider the use of match sticks luxury, how can one induce them to use those appliances and equipments intended to ease their daily lives as a prelude to make them more productive? There is no easy answer. We can only hope that improved technology would be introduced by the rural well-to-dos. In such a case there is every likelihood of monopolising the additional benefit accruing out of it by those rural 'elites'. Even if such benefits are allowed to be spiltover to the rural masses, these will only be marginal improvement in their economic condition. Therefore, in order to bring about changes in the conditions of rural people by popularising new found technology within the existing socio-economic structure would be almost futile. Even the number of rural elite who venture to apply the new technologies would be gradually declined, since there would be no further inducement to them in the absence of opportunities to employ the extra surplus generated in course of time and the process would close up their migration to more populous urban area. This looks like a bleak picture of the future but we have to accept the reality and try to form a package of programme to alleviate this situation.

## Issue of Transfer of Technology from Abroad:

Upto now we focussed our attention entirely on the problem of transfer of technology from research and production centres to the people in general within the country. Another area where we are turning now is the arrangement of transfer of technology from abroad. We are not in a position to ignore this vital aspect since socio-economic realities as they are at present would be gradually evolved to comprehend the needed

technologies if spill over effects are channelised to traditional sector from the modern sector. With this perspective in view, we are going to scrutinize the mechanism of transfer of technology from abroad.

In the above analysis we have emphasized implicitly or explicitly the limits of absorbptive capacity of particular community or communities with regard to transfer of technology. The same holds true in the case of international transfer mechanism as well. With this note of caution let me be more specific to country situation.

Nepal has been predominantly an agricultural country with traditionally stagnant agriculture. Since 1951 there have been efforts towards securing foreign aid for the development of infrastructure. Nepal launched her first Plan (1954 - 1961) during mid-fifties with foreign resources more than three-fourth of the total financial expenditure. This orientation towards securing foreign assistancehad increased during the Second Plan. Even while we are approaching the terminal year of the Sixth Plan period, foreign assistance is estimated to hover around three fifth of the total financial expenditure. It is not intended here to mean that foreign assistance should be curtailed as such, but only that domestic efforts should be geared up to an appropriate level so that total development outlays are substantially increased. Predominance of foreign assistance programmes in wrapped up packages have limited the local inquisitiveness and sensibilities and at the same time accentuated dependency even in simple matters. There is enough scope for changing the direction and content of foreign assistance programmes if sufficient alertness is shown at national level towards developing indigeneous technological capability.

There seems to be little awareness existing on the part of the policy planners even as late as 1981 that a proposal of foreign private investment should be assessed thoroughly in order to make it compatible with the broder national development objective. It was not thought necessary and still not practised in sufficient depth to scrutinise the relevance,

effectiveness and mode of implementation of a foreign assistance programme not to mention foreign aid which is a grant by any friendly government to the country. Anyway Nepal's Sixth Plan has underlined a need to shift her strategy from development of basic infrastructures to utilisation of those already created infrastructures for productive purposes. With this shift in strategy it was naturally aporopriate to give way to private initiative by creating a climate conducive to productive enterprises. Against this backdrop, HMG has promulgated a revised Industrial Enterprises Act together with a new Foregin Investment and Technology Act in 1981. The latter is therefore, a legal framework for the first time in Nepal to effect the transfer of foreign technology in a systematic way.

Nevertheless, there have been a few cases of transfer of technology as a result of contract between the parties and approval of the same by the HMG, as outflow of foreign exchange is subject to HMG's prior approval. Under this new Act, while approving foreign investment (it is assumed that foreign technology would be necessarily coupled with foreign investment) in Nepal, consideration would be given to -

1. Whether the proposed investment project is appropriate for or beneficial to Nepal;

2. Whether theinvestment is related to import substitution process or the development of exports;

3. Whether the investment project is to utilize local materials; and

4. Whether the investment project is to provide employment and financing opportunities to Nepalese nationals.

Among others, there are two other provisions in the Act which are important from the point of view of national technology policy. Article 14 of the Act stipulates that HMG is empowered to give guidance to enterprises in the following subjects (and it is obligatory on the part of such enterprises to abide by them):

1. Quality of production and services of such enterprises, price and distribution system;

2. Management of such enterprises;

3. Issues relating to maintain cordial relations between labour and management;

4. Issues relating to environmental pollution;

5. Issues relating to protection of public interest.

Article 18 of the Act empowers the HMG to frame rules to carry out the provisions of the Act specifically in the following areas (without prejudicing the power to frame rules in other areas):

1. To determine the nature of industries open for foreign investment and operation thereof;

2. To determine terms and conditions of foreign investment

3. To evaluate the tangible assets made available under foreign investment or foreign assistance;

4. Concerning payment of interest and repayment of foreign loans;

5. Concerning guarantee and security of foreign loans.

Despite these provisions, rules are to be framed as yet. In the absence of specific criteria, evaluation of foreign investment proposal would be subject to judgement and conscience of those participating in the decision making process. It is actually not conducive to favourable investment climate, since no party knows with a fair degree of certainty at the time of negotiation which proposal and provisions of the agreement is likely to get the approval of the government.

## Suggestions on New Linking Mechanism

### National Context:

We have noted at the outset while enumerating the area of RONAST's activities that as a national institute for promotion and development research activities as well as transfer of technology, RONAST should be fitted in these schemes so that appropriate linkage between research institutes and executing agencies be established. Unless research institutes are aware of the area of business needs and executive agencies like Ministry of Industry (MOI) and Department of Industries(DOI) and committees responsible for evaluating the proposals are aware of the technology options available in the country either through collection and processing of information and research efforts, no meaningful and cost effective transfer of technology can take place in the country. There appears to be a need to reinforce this perception at the policy formation level and therefore a strong coordinated action in furtherance of this objective should be the immediate concern of the government.

Another arrangement which would be helpful in the commercialization of research results is by promoting pilot projects (which have scope for wider application) by government agencies or other agencies with close supervision of research institutes. In the initial stage of applications of research results, there are numerous risks associated with it and capability (financial as well as technical) of the private sector only will be too limited to cope with them. In this context either joint venture of the government and private sector should be arranged, or some sort of subsidy to private investor for a certain period of tire should be arranged.

## Linking of National and International knowledge base

Despite numerous problems on research as well as commercialization fronts, one cannot set aside the urgency of their fruitful application in the least developed countries like Nepal. It is a known dictum that one need not reinvent the wheel in the name of research. Similarly commercialization does not take place in an alien land like grafting. Therefore, if there is a need to have an inventory of research results which can be applied in a similar situation, there is also an equally pressing need to dovetail the various elements of such research results prior to their application. In this context we should not undermine the role of a central national body which keeps itself abreast of new research results in a foreign country and monitors and guides the national efforts in a systematic way. Various international agencies and institutes which are engaged in the dissemination of research results and are providing advisory services in the case to case basis should not shrink their activity. They should rather broaden and deepen then involvement in this regard. It would be meaningful to channelize the information through a responsible medium, so that necessary local modification on these devices and substitution of materials could be introduced at an appropriate stage.

Although commercialization of research results is a time consuming and slow process, it is still theonly better way left at present to accelerate the pace of industrial development.

## Conclusion

In sum, the problem of commercialization of research results as well as technology transfer cannot be solved unless a comprehensive national development framework is formulated and unless a strong will to implement it is manifested in action. International organizations involved in these area can only help by informing the scientists and technologists, engineers and economists, bureaucrats and entrepreneurs by arranging training programmes to enable to carry out the task, by availing research and

laboratory facilities within the country, so that indigeneous capability to identify and exploit the opportunity is developed. The countries concerened in most cases have their own social milieu and special problems which they are only in a position to solve.

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# COMMERCIALIZATION OF RESEARCH RESULTS: THAILAND EXPERIENCE*

by

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INTRODUCTION

The prospect of entering into modernization through industrialization is something that is always nurtured in any able mind in all developing nations. Research for the sake of learning and achievement has long been well accepted by scholar trying to achieve earthshaking or revolutunary result as the end product. However, putting research result that is saleable into practice is something which is entirely different. Research results will need to develop further with engineering design, resulting in machine that will repeatedly reproduce a large number of goods with sturdy, usable, nice materials and of course with saleable quality. Achievement of such, is the starting of the industrialization or we can say that such products have already been commercialized.

Developing countries have generally realized that the tools of the trade that is "technological resources" is lacking or almost absent in most cases. It has been proven beyond doubt that technology is essential to economic development and very indispensable to the modernization of the nations. Therefore, they have generated great demand for the transfer of advanced technology in the earliest and fastest way possible. In most cases, these countries do not have sufficient technological structure to absorb such technologies and thus do not achieve effective transfer as it should be. A technological unit which will both modify and improve as well as adapt imported technology is

missing. Industrial Research and Service Institutes (IRSI) usually have been established to fill up these gaps, usually with the assistance of Governments. Most developing country governments have invested substantial sums in IRSIs and there is a general demand for some return on the investment in term of economic and social gain. The fact remain nevertheless, that the commercialization of the R&D results of most government sponsored IRSIs in many of these developing countries is very limited in comparison with what is needed by industry. The successful management and operation of an industrial research and development institute in a developing country is not an easy proposition. Apart from being good in any particular fields of R&D according to the national priority, it needs to be realized that the ISSIs are set up primarily to help existing industries and catalyse new ones. But the other role which include development and commercialization of a modified or new product or process is not strongly recognized and promote as it should be. Some of the reasons for lack of commercialization have been identified e.g. absence of market analysis and techno-economic feasibility studies, unvillingness of industry extrepreneurs to take risk, lack of fund to operate, lack of good rapport with industries etc. Many of these problems will be point out under Thailand contition, with successful and unsuccessful case studies. The systematic use of all available capabilities and resources in an organized form is an indispensable factor in achieving success and culminating industrialization through effective ISSIs and industry linkage of any developing countries.

1. Problems facing Implementation of R&D Results

In Thailand, as in many struggling developing countries where development to achieve modernization of the nation is the top most important issue facing the country as a whole. Let alone the question of playing the underdog role in competing with developed nations to obtain and trying to process high and sophisticated technologies. It is therefore, appropriated to separately identify the question of R&D results and the question of implementation commercially of the feasible ones:-

R&D results:- Many of this R&D projects do not have enough impact sufficient to be process further to industry. In many instances, choice of the R&D projects which have good market potential had been overlooked. The government, however, allots a very low percentage of GDP for R&D activities i.e. only 0.018% of GDP while USA, Japan, England and Germany have given a much higher figures.

Table 1 Comparison of R&D expenditure per percentage of GDP

| | |
|---|---|
| U.S.A. | 2.8 % of GDP |
| Germany | 2.5 " |
| Japan | 2.2 " |
| England | 2.0 " |
| Thailand | 0.018 " |

Imported R&D results are usually proven to be commercially viable and in Thailand large amount of the so called proven technology have been introduced into the country either by licensing, royalty, trademark, franchise or joint venture. These technologies have not been or do not pass through the proper transfering process where we can skillfully retained them. The normal trend indicates a gradual increase

in buying foreign technology.

Table 2 Depicts the increase of imported technology to Thailand

| Year | Imported technology (Million dollars |
|---|---|
| 1978 | 24.1 |
| 1979 | 31.4 |
| 1980 | 40.7 |
| 1981 | 57.8 |
| 1982 | 62.7 |

It had been repeatedly mentioned that acquiring the know how knowledge through buying or imported technology is something that should be done, particularly when that technology is lacking. As a follow up feature, however, the country should have personnel and technological structure which will absorb and digest as well as readily transfer such technology. It is here where many developing countries as well as Thailand set up a multi-disciplinary institute particularly of IRSI's nature. This is to activate R&D and to play a leading role in absorbing the technology and initiating the nation's industrialization.

The Implementation Stage: New imported technology after the period of R&D as well as adapting or absorbing of the technology need two important steps to be completely commercialized. These two steps are:-

(E) Engineering design and prototype development and (I) Industry (production), It is often believe that a commercially viable R&D discovery will immediately yield a profit when implement, we know now that this is not always true. In fact, these two stages acquires a much higher investment, take more patience and effort than the actual R&D stages. The marketing demand and the quality control are the two added activities that are crucial for successful commercialization of the R&D results.

Some of the common problems which have been overlooked in the implementation of the R&D results, particularly in the small and medium scale industries are as follows:-

1. Lack of financial source for the venture.
2. Lack of managerial skill in the process of setting up industry.
3. Having no or few specialist to oversee the process.
4. Lack of support & exemption of tax or some meaningful incentives from the Government.
5. Lack of business management or knowhow to operate new venture.
6. Lack of good rapport with related private enterprises.

2. Case studies

The experience in commercialization of the research results by TISTR has had some mix success. Most of products are mainly in agricultural products or agro-industry.

Garlic natula - a water soluble garlic extracts powder has been developed by TISTR directly from R&D, bench scale and pilot scale. At present a private company has set up factory and the production expects to come out into the market very soon. Many other medicinal plants products including essential oils are in various stages of research and development.

Nursery blocks. The process in developing good practical nursery block has strong impetus in Thailand reforestation program. TISTR had perfected the process, one private company had picked up the technology and put in production. However, the products did not stand up to the expectation and the standards quality control has been poor, finally,

the company had to stop operation.

Many other potentially research results at TISTR do have strong to very strong possibility, but the question of marketing and the quality control loom up to be one of the strong bottom-neck in the deliberation.

Another commercialization connecting with a private company dealing with high technology is worth mentioning. This company produces electronic parts - circulator & separator for microwave equipment & the company met with good, solid success story. The products are well accepted world wide, amongst the customers are United States NASA program. In this endeavour, the technology belong to the company, but Ministry of Science, Technology and Energy through TISTR join in with capital (for a certain period of time) plus direct assistance in management and directive policy of the company. Related enterprise dealing with solar cell production is also being set up with TISTR involvement.

4. Linkage of R&D Institute and Industry

The question of having good rapport with the industry is something that needed to be taken seriously. One of the major endeavous for R&D institutes is the establishment of linkage with universities or basic research institutions on one hand and the private enterprises or industries on the other. Such linkage is significant regarding the understanding between bonafide academicians and the practical, profit oriented industrialists. Applied research relatively meaningful to industrialist can not be easily realized by the serious researchers. Another point worth mentioning is the question of building credibility of the institution. This problem may be most difficult to realize in earnest if we do not really know what actually the industries want.

Linkage through "liason reach out unit" which should be set up in each IRSI; employing on a part time basis, a number of personnels who are presently working or having a good linkage (from association or board members) selected from various business fields. Another linkage that can be realized is the exchange of personnels through project operation or new technique training between institutions and various industries.

There are three very important issues directly relevant to industrial demand, these are information, money and new improved technology.

Industrialists need information, any up-to-date information about new marketing channels movement of business trend, new technology, improved procedures etc. In the regional or global setting, information can be obtained through a net work which will be set up or improving any existing information co-ordinating body in the region.

Another linkage that always hold true in any situation is the linkage through "funding". This financial set up could be operated on a reciprocal basis between IRSIs or industries. IRSIs may operate as joint venture or may invest some capital in promoting certain relevant industries, particularly in small & medium size industries. Industries on the other hand can give out on contract research basis for any problem solving type of sturdy or exploring in various new fields or new technologies.

Any new improved technology will affect industry tremendously, particularly if competitor get hold of it. If IRSI has or develops new technique or new technology, it will definitely improve its bargaining power or credibility up to the point where linkage can be most effective and lasting.

5. The present trend

In Thailand, recently strong popularization of science and technology has been most effective. People from all walk of lives as well as politicians have had a better & more awareness of the impact of science and technology to the country and to everyday life. The Ministry of Science, Technology and Energy which only came into existance since 1979 opts its operation, apart from creating awareness in S&P briefly into the following:- Assists in enacting new laws to assist and promote S&T overall, increasing funds from both government budget and foreign assistances for various promoting activities, and direct operation with the main thrust through TISTR which is the only non-profit making public enterprise organization in the Ministry.

TISTR direct its operation into building capability and credibility in the selected fields relevant to the immediate needs of the nation. The two major emphasis will be the role in research and development and the role in services relating to science and technology.

The role in research and development will cover 4 main issues:-

1. TISTR R&D program shall cover all disciplines with direct response towards sturdy and strong development with self reliance as well as keeping abreastwith the world particularly in the industrial sector.
2. All research will direct at applying the research result towards production of goods both local and foreign.
3. All R&D operation should be conprehensive covering from R&D to engineering design and industrial production or commercialization.

4. All R&D aims at creating technological capability of the nation by self developing or improve imported technology to attain higher efficiency and to retain the technology to the country. The 5 roles in S&T services will cover the following issues:-

   1. A centre for information, digesting and assimilation of technology is urgently needed to improve & function in full.
   2. A centre for engineering consultant is set up to assist in major government or big private development projects, particularly in designing and consulting.
   3. Giving service in contract research and development for industries and any other feasibity or environmental impact studies.
   4. Giving services in quality controls, standard and equipment testings. Building reliability and capability in testing and certifying materials and equipment for both government and private concerns.
   5. Giving service in engineering design from bench or pilot scale to production scale in order to creating self reliance in important factory materials & equipment.

In total, the present trend in science and technology in Thailand, direct at building capability in the country so that ultimately, we can be prosperous, rich, sturdy and strong nation with self reliance and able to abreast with the developed world.

## 6. Conclusion

Commercialization of the research and development results is not an easy task but it is indispensable in the context of developing countries. Stronger efforts from government and private sector alike are needed to build a concerted effort in obtaining capability in R&D as well as relevant services through the completion of the cycle of achievement. Thai is from research and development through bench scale and pilot scale, following with engineering design with prototype development and finally into industry with production and marketing demand.

In Thailand, TISTR met with mix success in commercialization of the research results in the past. The present set up with strong deliberation of S&T popularization prompts the stronger linkage through IRSI and Industry with the improve capability and credibility. Support through meaningful S&T policy and planning from the authority concerns is indispensable for any deliberation in S&T anywhere.

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# COMMERCIALIZATION OF RESEARCH RESULTS IN PARTICULAR REFERENCE TO ENGINEERING SECTOR OF PAKISTAN*

by

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Today, more and more areas of our life are being influenced by technology. From nuclear weapons to nuclear power, from space exploration to satellite based communication system , from production by industrial robots to genetic engineering , life is directly and increasingly being shaped by technology. In this perspective , the immediate need for the much neglected area of Research & Development acquires urgent importance for a developing country like Pakistan. Pakistan is lagging behind significantly in research efforts. There are very few institutions in the country which are rendering such services. As these institutions are manned by poeple possessing highly advanced skills and vast experience , the cost of services of these institutes is high and beyond reach of small scale investors. Most of the research and development activity in Pakistan is undertaken by such R & D centres as sectoral research councils and institutes of the federal government , universities , provincial research institutes , extension / advisory stations and testing and survey units. The most important research organisations are :

(a) Pakistan Council of Industrial & Scientific Research.

(b) Appropriate Technology Development Organisation , Islamabad.

(c) Pakistan Industrial & Technical Assistance Centre, Lahore.

(d) Cotton Textile Industrial Research & Development Centre, Karachi.

(e) Metal Industrial Research & Development Centre, Lahore.

(f) Sugar Research Institute , Hyderabad.

(g) Leather Industry Development & Research Organisation, Islamabad.

2. These research institutes although give an impression that there is a well developed infrastructure and considerable research activity in the country, yet this appearance is rather misleading because notwithstanding their number the effectiveness of research in these organisations is greatly impaired due to very severe weaknesses afflicting them. Some of them are :

(a) Sub-critical level and excessive fragmentation of scientific R&D effort measured in terms of personnel , equipment , funding etc.

(b) Want of conducive environment for creative research work resulting from factors such as inappropriate organisational structure , cumbersome financial and administrative procedures , lack of professional freedom.

(c) Absence of effective mechanism for linkage of research efforts with country's economic planning process.

(d) Isolation of the scientific research community from the production sector of the economy, their research efforts thus lack the sustained momentum that can come from its channelisation towards variable goal.

(e) Lack of effective communication and dissemination of research results to the prospective end-users , absence of appropriate mechanism for proper utilisation and commercialisation of research results.

3. In view of the above, Government of Pakistan has set up a high powered National Commission for Science and Technology ( NCST ) which inter alia , was entrusted to formulate effective policies regarding promotion of fruitful research activities in the country. Special emphasis on research and development was laid in the country's 6th five year plan ( 1983 - 88 ) as can be noticed in the Government of Pakistan's industrial policy statement in this regard.

"..... Private sector will be encouraged to set up R&D facilities industry-wise. For this purpose, industries will be asked to earmark a small part of their pre-tax profit for R&D . Government has already allowed deduction from income from business or profession of any amount paid to a recognised scientific research institute or a University to be used for scientific research or technical training related to the business of the assessee. Similarly , any expenditure directly incurred on scientific research in Pakistan related to the business carried on by the assessee or any amount donated to the Fund for promotion of Science and Technology in Pakistan is, subject to certain limits , eligible for deduction for the purposes of income-tax. The private sector must fully avail of this concession to set up R&D institutes or contribute to a recognised R&D Fund in the private sector. The R&D should aim at :

(i) filling up of technological gap ;

(ii) perfection of designing aspects and catering to the changing preferences in foreign market ;

(iii) quality standard improvement ;

(iv) packing and packaging improvement ;

(v) absorption and diffusion of technology , after import , on national level , and

(vi) effective capacity utilisation and increased productivity.

The proposed industrial policy and procedure committee will periodically review progress of R&D efforts by the industry and institute necessary corrective measures , if so warranted by the situation ..... "

4. Accordingly NCST made various recommendations which can be summarised as :-

(a) All the existing research institutes may be given an autonomous character and should undertake goal oriented research in accordance with national objective.

(b) Adequate finances should be provided to ensure effective implementation of programme. Financial and administrative procedures should be simplified.

(c) Serious deficiency in adequately trained manpower in research institutes should be made up as speedily as possible.

(d) Research institutes must be provided necessary resources and develop adequate pilot plant facilities.

(e) R&D cells should be established in all nationalised and large private industrial establishments for facilitating technological improvements on a continued basis.

(f) Scientific consultancy services in various technical fields including R&D work should be organised in the public sector on commercial lines to cater for important projects within the country and abroad.

(g) Research in universities should constitute priority goal and the requisite budgetary provision made to achieve it. For this purpose well-equipped laboratories must be provided as quickly as possible.

(h) Joint committees of representatives of industrial and research establishments should be set up to provide liaison and linkage between the two sides.

(i) A national centre for technology transfer should be set up to assist, inter alia , in collection , analysis and dissemination of information on technologies and to render advise, when asked for, regarding negotiating technology agreements on most favourable terms and in unpackaging technologies. This centre besides maintaining liaison with technical cells in the ministries / departments will also maintain a data bank for storage and dissemination of information regarding plants , machinery , processesses and results carried out locally and abroad.

(j) Local consultants should be actively associated in all capital projects including foreign aided projects , as far as possible , on the basis of experience.

(k) Availability of high level manpower for research activities should be ensured through training , exchange of personnel between universities and R&D institutes , deriving maximum advantage from the national talent pool scheme , utilisation of retired eminent scientists and technologists on contract appointments , improving service conditions and providing incentives for scientific and technical manpower , creating conducive environment for creative work etc.

(l) Isolation of Pakistani scientists and technologists from world centres of knowledge should be removed by providing adequate opportunities for close international liaison.

5. Thus for the first time, a comprehensive plan and the policy package for the promotion of research in science and technology has been formulated by the government which if persued in its entirety will have far reaching effect on the commercialisation of research activities in the country , and provide proper linkages between research , industry and institutes / universities.

6. In pursuance of the above policies , research and development cells have been created in the major units of the country for example , State Engineering Corporation of Pakistan which controls and manages a wide cross-section of the engineering industry in the country producing variety of complete plants and capital machinery , light engineering goods and steel rolled products in the public sector has created R&D cells in all its operating units. The units are spending about 1% of their total sales turnover depending upon the nature of the R&D activities being persued by them. The present R&D activities are directed mainly towards improvement in quality of the existing products , product design and manufacturing techniques in order to improve the competitiveness of these products in the market. Thus the commercialisation of the R&D results has been the main objective of the R&D of the units. The examples which follow would show that encouraging results have been achieved in the commercialisation of development activities on research persued in these units :

(a) A metallurgical factory in public sector producing intermediary engineering products such as castings and forgings was able to improve its sales by about 10% primarily on account of research and development through improvement of metals ( iron and steel and non-ferrous metal ) , their quality and reduction in cost.

(b) Another unit in public sector producing light engineering goods such as pumps , diesel engines , electric motors etc has been carrying out its R&D activities on the improvement of design of

electric motors and improvement in horse power / weight ratio of diesel engines in order not only to maintain their share but also to increase it in a market which has recently become highly competitive. The company has met with partial success and been able to increase its share in the market in respect of these products by 3%.

(c) Yet another unit producing complete plants and heavy capital machinery had to face severe competition against similar imported products and was compelled to quicly improve design and technology employed in its product which should conform to the international standards. In this connection two pronged attack was launched. Firstly , technologies were acquired from the internationally reputed firms of industrialised world and secondly, in house R&D activity has been accelerated to improve its own products. This company has also achieved success in not only increasing its sales in local market but has also been able to confidently offer its products to foreign market.

7. Engineering industry however is a difficult and complex sector. Research is costly in this area and funds for such purpose are limited, sometimes not available at all. In addition , in a developing country like Pakistan , engineering units are always confronted with the import of similar products from giant multi nationals who have the

advantage of economy of scales. Consequently, the profit margins of the engineering industry of developed countries like Pakistan do not allow R&D at the grass root level. In the final analysis, they have to fall back upon the recourse of acquiring readymade available foreign technologies and then if necessary make an attempt to further improve upon them. It would therefore be imperative for a company in a developing country to most judiciously utilise its resources on R&D and concentrate its efforts only in such areas which promise better chances of success and quick return as otherwise the limited funds available for this purpose would be ill spent, without bringing any commercial results. For the illustration of this point two case studies are cited below.

8. Case Study - I

8.1 One of the companies in Public Sector undertook development of a 'reaper' for harvesting in late 1981. The 'reaper' was driven by an agricultural tractor. The Company had undertaken this R&D work hoping that with expected rapid farm mechanisation in Pakistan considerable demand for reapers would be generated.

8.2 The design of the reaper had to incorporate the following main points :-

(a) Consistency with local farming practices

(b) Relatively higher speed of harvesting

(c) Minimum shattering losses / grain losses during harvesting.

8.3 In order to arrive at the main features of the reaper and its technical specifications , discussions were held with agricultural experts , Agricultural Research Institutes and the farmers. It transpired that the reaper using overhead collector reel mechanism with inclined flat belt conveyor had faster cutting speeds and minimum grain losses. The development work was therefore concentrated on this type of reaper in association withcountry's Agricultural Machinery Research Institute ( AMRI ) in September, 1981. The first proto-type was produced and tested in December 1981. As a result of this test / trial certain modifications were identified necessary for improving the design. For example , the main structure frame was found to be weak. The drive arrangement needed modification , wooden cleats on the conveyor belts needed to be replaced by rubber lugs and the speed of the cutter needed to be increased.

8.4 After incorporating the above modifications second test / trial was carried out in April 1982. Subsequently more modification had to be made in the design for improvement. The third trial of the modified prototype was carried out in December 1982. This time the performance of the reaper was found to be more satisfactory. Finally, extensive field test trials were carried out by a team of experts

and also by the farmers / users. This time again, certain structural machine elements weaknesses were discovered after long use of the equipment. In the period January to June 84 the design was perfected

and it was confirmed that failure of components was far less than those in similar competitor's models.

8.1 The development work took about 3 years and during this period company had to spend its considerable resources on this job. Unfortunately, commercialisation of this development posed immense problems and therefore return on the investment made on R&D of the product is yet to materialise. Although the product has been designed specifically to suit local conditions, yet the Pakistani farmers are hesitant to adopt mechanical means of harvesting as they are accustomed to manual farming practices. It was proved to the farmers through actual test / trials that the grain loss in manual cutting was about 3 to 4% while in case of reaper the losses were only 1%. This obviously meant considerable benefit to the farmers. It is hoped that with education of farmers, extensive demonstration of the equipment and persuation / incentives provided to the farmers the use of the reapers would increase in coming years.

9. Case Study - II

9.1 Yet another company , also in the Public Sector , undertook development of a small agricultural tractor in the year 1971. The need for this development was felt in view of the government's stress on the early mechanisation of farming in the country, and the reports of success of small tractors in farming in countries like India , China and other Far Eastern

countries. The design work was initiated in late 1972 based on a proto-type of a small tractor available with one of the agricultural engineering workshops. The first proto-type of the tractor was produced in March 1973 along with certain implements. The design incorporated locally available materials and components. The prime mover of the tractor was a locally made diesel engine. The proto-type was subjected to thorough investigations under local field conditions. For this purpose 20 proto-types of the tractors were produced and distributed to some of the renowned agricultural research institutes, government farms and some progressive farmers for undertaking extensive field trials. During trials it transpired that the machine was not suitable for the job it was designed to handle. The main weaknesses noted in the design were : inadequacy of power, inadequate ground clearance, defects in transmission and clutch mechanism, the belt drive system, and the manual control system.

9.2 The design of the tractor was modified to remove the defects mentioned above and subsequently field trial tests were undertaken once again. This time the performance of the tractor had improved -- yet it was far from perfection. The development work at this stage had to be discontinued for lack of finances. It was also felt that the cost of production of this tractor was very high as compared to similar imported tractors. Hence even if the design had been perfected there was little chance for successful commercialisation of this product in the country.

10. Conclusion :

This is only a short account of the current scene of the commercial research and development in Pakistan. A country which has managed to acquire fairly respectable profile in the field of industrial development and technological know-how has to attend to its R&D needs far more aggressively but selectively. It can not afford to fritter away its limited resources and energies on entering basic research in all fields and every conceivable sector. At the same time, it cannot neglect the scope of original and essential research which the country's industry , agriculture and techniques call for in order to provide dynamism and competitiveness to its over all economic development.

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# COMMERCIALIZATION OF INDUSTRIAL RESEARCH RESULTS IN INDONESIA*

by

Garjito Pringgo Sudirdjo**

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* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has been reproduced without formal editing.

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INTRODUCTION.

The most important criteria of successful application of industrial research is the commercialization of its research results in industry.

By commercialization, it is meant that research result is being utilized in industry for commercial production, whether during the transfer, financial arrangement is involved or free of charge.

By experienced, unsuccessful commercialization are mostly influenced by factors like : no close relationship between research institutions and industry, financing constraint, uncertain soundness of research results and lack of promotion.

In Indonesia, these factors are also hampering the development of the domestic commercialization of the industrial research results, besides most of the large industries with foreign joint undertakings are receiving their know how from their parent companies abroad. More-over, all the industrial research institutions in Indonesia are government institutions, where as a non profit organization are not allowed to do contract research. All research projects in the institutes are previously planned in a certain fiscal year and the research funds are coming from the government budget, which are limited.

To coup with these bottlenecks, means are taken by increasing the relationship between research institution and industry; changing the law, to ensure government research institution be given the opportunity to do contract research directly with the industry; coordinating and directing research projects to be more responsive to the industrial needs;

establishing a government policy which will regulate the use of imported technology, and last but not least, improving the capabilities of the research institutions itself.

A linkage between regions, by establishing a net work system, where exchange of experiences, techniques and methods on transfer of technology to industries can be obtained, will be very useful for the acceleration of commercialization of industrial research results.

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## I. COMMERCIALIZATION OF INDUSTRIAL RESEARCH RESULTS

### a. Industrial research institutions.

Most of the industrial research institutions in Indonesia are Government institutions, and some of them are research institutions of large Government owned company (e.i. fertilizer and cement industry). Others are owned by private companies where mostly are foreign joint enterprises, who introduce foreign technology from their parent companies; these companies do not see the need for technical services from domestic research institutes.

The industrial research institutions mentioned in this paper are institutions under the Agency for Industrial Research and Development, Ministry of industry. There are nine National and Sectoral Research Institutes who cover the industry according to major group of industries of the ISIC.

The nine research institutes are listed in the Annex, including their scope of work and main activities. Besides these sectoral institutes, who are all located in the most developed and crowded island of Java, there are also nine Laboratory and Testing Institutes with regional scope, seven are located in the other islands e.i. Sumatera, Kalimantan, Sulawesi and Ambon,and two of the remaining are also located in Java .

The main functions of these research institutes are: research and development, engineering, trouble shooting, training, and publications of their research results, where the testing institutes are mainly doing testing for industrial products.

b. State of art of commercialization.

As mentioned above the nine industrial research institutes, including the nine testing institutes are coordinated by the Agency for Industrial Research and Development, but the programmes and selections of their research projects are done by the institutes themselves. The Agency is merely deciding the priority projects related to the needs of the industry and budget allocations. These in-house research projects are financed by the Government Development Budget and their objectives are to solve the problems encountered by the industry.

The above mentioned selected research projects are programmed for the next fiscal year, and once they have been decided, it will be difficult to change them. Typical research projects are: Utilizations of local raw materials for substituting imports, improvement of industrial products, new process design and process modifications and prototyping of machineries: exploring new raw materials and technical assistance to small scale industry.

Except for certain sectors of industry, generally no close relationship exist yet between the research institutions and industry, resulting research projects which are not directly applicable in industry. In cer - tain industrial sector, close relationship exists through Industrial Associations where research institutions are members.

To promote the development of small scale industries, a linkage is established which is called BIPIK. A Government organization, BIPIK coordinate all the technical services needed by the small scale industry. For certain technical services, BIPIK are able to render its services directly to the small scale industries, but it advanced know how is required, BIPIK may mobilize other research institutions. The objectives of their system is to assist the small scale industry improving the products and modernize them for becoming sub-contractors of large-medium scale industry. A deletion program for certain commodities or products is being introduced, so that large-medium-scale industry are not allowed to produce these items. It seems that through this system, commercialization of research results has occured.

For large and medium scale industry, the commercialization process is still in an initial stage or practically non-existent. For the past fifteen years, most of large-medium-scale industries are foreign joint undertakings who introduce foreign technology from their parent companies abroad, which are more up to date than technology owned by the industrial research institutions. In this condition, and without improvement of their capabilities, the research institutions are not in the position to commercialize its research results to large and medium industries.

To ilustrate some example of the commercialization of research results, several case studies is mentioned below.

c. Several case studies on commercialization of research results.

i. water meter housing.

For the production of water meters required by the National Housing Project ( PERUMNAS ), the Institute for Development of Metal and Machineries Industries ( IDMMI ) formed a joint project with the National Instrumentation Institute of the Indonesian Institute of Sciences. IDMMI is responsible for the production of the water meter housing. To produce the metal housing, several small scale industry complexes was mobilized. The prototype and technical assistance was given by IDMMI to the small scale industry. During the early stage, the capabilities of the small scale industry was very low, but with constant guidance and introducing new techniques, including standardization and quality control, the project was a success. The project which lasted one year has produced 200.000 water meters housing with a total value at about US $ 1.500.000.- the quality of the waters are comparable with the imported one.

ii. Military personnel supply.

Two industrial research institutions e.i. Institute for Research and Development of Textile Industries ( IRDTI ) and the Institute for Research and Development of Leather, and Allied Industries ( IRDLAI ) was given the task by the Indonesian Army to design standard military supply for personnel e.i. shoes and textile for uniform. The production of the comodities was given to medium scale industries.

The prototypes are field tested, redesign and finally accepted, and is now becoming a standard commodity for the Army. The annual total sales values for both commodities e.i. shoes and textile for uniform is estimated about US $ 1.500.000 and US $ 5.000.000 repectively.

iii. Commercial vehicle ( mini truck ).

With the increasing capabilities of domestic industries to produce automotive parts (about 60 % at the various parts needed ), a prototype of a commercial vehicle is designed by IDMMI. This 2 tons mini truck is designed using all the local components available and it intended to be a standard commercial vehicle in the future. The prototype is then tested, using standard procedures and the results are promising. No positive response was received for product development and commercialization of the prototype from the local automotive industries, of whom all of them are extension companies of well known automobile producers in the world.

II. PROBLEMS ENCOUNTERED DURING COMMERCIALIZATION.

From the past experiences, several critical problems are identified :

a. That existing law / regulations might hamper the process of commercialization of research results especially for Government research institutions.

b. No positive response is given by large industries with foreign joint undertakings for the commercialization of domestic research results; since their technology back up comes from their parent company.

c. No close relationship existed between the research institution and the industry, so that many research projects are directly applicable in industry through commercialization, or that the research results are only at exploratory research stage with no clear prospects.

[illegible] capabilities of the research institutions for some institutions are, [illegible] velopment of new technology.

## III. MEASURES AND MEANS FOR COUPING THE BOTTLENECKS.

To coup with problems and bottlenecks encountered during the process of commercialization, meanners and means have been taken, by:

(1) Changing the regulation/law for Government and research institutions, which enable them to conduct contract research directly with the industry. This opportunities will give the institutions experience and made them more responsive towards the needs of industry.

(2) Establishing linkages and setting-up mechanism of net work between the research institutions and industry through Industrial Association, where the institutes are members. These linkages will help set-up close relationship between institutions and industry.

(3) More accurate selections of in house research projects to the direct needs of industry. The right selections of the projects will ensure. More effective application and commercialization of the research results.

(4) More active promotion and publicity of research results especially those who successfully commercialized by the industry. It will informed the industry of the existance of research institutions in the country.

(5) Strengthening and improving the institutions capabilities, through joint research cooperations between domestic research institutions with similar institutions in developed countries. With the increasing capabilities of the institutes, it will help to change the image and trust of the industry toward research institutions.

(6) Recommending certain measures, e.i.; establishing national policies for regulating imported technology especially for large industry with foreign undertakings, gives incentives for industry who is willing to commercialize a certain indigenous research results, and establish a regional network between less developed countries to improve and accelerate the commercialization of the research results of its

member country.

## IV. SUGGESTION FOR A REGIONAL NETWORK.

To accelerate the commercialization of industrial research results, especially in the less developed countries, a regional network between these countries sponsored by UNIDO should be organized.

The main functions of the network would be to suggest:

(1) A periodic exchange of methods and techniques on the commercialization of research results.

(2) Mutual visit of senior officials, in charge of commercialization of research results in their countries.

(3) Training programmes in the commercialization of new products and processes, especially for commercialization know how and management.

(4) Seminars or workshops, in which research results, problems encountered during commercialization and other special subjects of interest between research institutions and industry can be presented and discussed periodically.

Such a cooperative network would make better use of the limited facilities, research staff and financial resources in the member countries.

In connection with this regional network, the cooperation of Governments of each member country would be necessary

ANNEX

LIST OF INDUSTRIAL RESEARCH INSTITUTES

UNDER THE

AGENCY FOR INDUSTRIAL RESEARCH AND DEVELOPMENT

MINISTRY OF INDUSTRY

| NO | NAME OF INSTITUTE | ABBREVIATION | SCOPE OF INDUSTRIES | MAIN ACTIVITIES |
|---|---|---|---|---|
| | Institute for Research and Development of : | | | |
| 1. | Chemical Industries, Jakarta. | IRDCHI | - Pesticide, fertilizer, and plastic. | - Early stage on formulation techniques.<br>- Standardization of plastic, fertilizer and rubber components. |
| 2. | Agrobased Industries, Bogor. | IRDABI | - Edible oils, food and other agricultural product. | - Improvement of essential oils process.<br>- Design and prototyping of agriculture equipments. |
| 3. | Textile Industries, Bandung. | IRDTI | - Textile, spinning, knitting, weaving, finishing. | - Feasibility studies.<br>- Design machinery e.i : weaving loom. |
| 4. | Cellulose Industries, Bandung. | IRDCLI | - Wood and non wood based. | - Pulping techniques of various raw materials for paper and disolving pulp.<br>- Product design for special paper e.i : cigarette, computer paper. |
| 5. | Ceramic Industries, Bandung. | IRDCRI | - Art ceramic, refractory and glass. | - Process design for refractory<br>- Development of ceramic raw materials and the improvement of production process. |
| 6. | Metal and Machinery Industries, Bandung | IDMMI | - Metal working<br>- Machinery. | - Design mould and dies.<br>- Design and prototyping of agricultural machineries. |
| 7. | Materials and Technicals Product Industries, Bandung. | IRDMTPI | - Quality assurance. | - Quality assurance for pressure vessel and boilers. |
| 8. | Leather and Allied Industries, Yogyakarta. | IRDLAI | - L e a t h e r<br>- R u b b e r<br>- Syntetic leather. | - Improvement of tanning processes for various kind of leather.<br>- Leather, especially foot wear, and limited industrial leather product. |

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 9. | Handicraft and Batik Industries, Yogyakarta. | IRDHBI | - Batik, and<br>- Handicraft; brass, silver. | - Promotion and improvement of the quality on batik and handicraft, especially for export. |
| | Laboratory and Testing Institute for Industrial product in : | | | |
| | Banda Aceh, Medan, Palembang, Surabaya, Banjarbaru, Ujung Pandang, Manado, Ambon. | | - General industries | - Testing of material products. |

Remarks : All these institutes are involved in :

- giving technical assistance to small scale industry
- industrial standardization (preparation and application)